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# FARM PRACTICE IN THE USE OF COMMERCIAL FERTILIZERS IN THE SOUTH ATLANTIC STATES.

BY

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# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
*Washington, D. C., February 4, 1910.*

Sir: I have the honor to transmit herewith a manuscript entitled "Farm Practice in the Use of Commercial Fertilizers in the South Atlantic States," prepared by Mr. J. C. Beavers, of the Office of Farm Management of this Bureau, and to recommend its publication as a Farmers' Bulletin.

This manuscript deals particularly with the fertilizer practice of farmers on the more important soils of the South Atlantic States in the growing of staple farm crops. It is hoped to publish later bulletins dealing with the fertilizer practices which have been found effective in other sections of the country.

Respectfully,

G. H. Powell,
*Acting Chief of Bureau.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# FARM PRACTICE IN THE USE OF COMMERCIAL FERTILIZERS IN THE SOUTH ATLANTIC STATES.

## INTRODUCTION.

The rapid increase in the use of commercial fertilizers during the past few years has created a growing demand for more information concerning them. Many experiments have been conducted which show the effect produced by using the fertilizer constituents singly, in twos, and in threes, but much more information is needed by the average farmer concerning the quantity and the proportion in which the fertilizer constituents should be used under a given condition of farm practice on a certain soil. This knowledge is essential to the farmer to prevent his wasting money in purchasing more of any one kind of fertilizer than is necessary to produce the most profitable crops.

To make heavy applications of fertilizer is costly. The increase in the yield of crops from the use of heavy applications of fertilizer on soils deficient in humus does not always correspond to the increase in the quantity of fertilizer applied. By increasing the humus content of the soil the yield of crops will be nearer in direct proportion to the quantity of fertilizer applied. Because of the frequent failure to observe this fact there is often a great deal of waste in the present methods of using fertilizers. To prevent this waste the farmer needs to know more about the fertilizer constituents in fertilizers and the factors which influence their use.

In order to obtain practical information upon this important problem an investigation of farm practice in the use of fertilizers was begun. In this work the endeavor was made to visit the best general farms located on the various soils in the most representative farming sections of each State. The farmers, as a rule, were interviewed on their own farms, so that a study could be made of the influence which the rotation of crops and the methods of farm management had on the use of fertilizers.

The most successful and economical use of commercial fertilizers is influenced by a number of factors. Before giving the detailed results of these investigations some of the more important of these factors may be profitably discussed.

## FACTORS WHICH INFLUENCE THE ECONOMICAL USE OF COMMERCIAL FERTILIZERS.

Some of the principal factors which influence the use of fertilizers are (1) the rotation of crops, (2) the growing of legumes, (3) the use of green manure and winter cover crops, (4) the use of barnyard manure, (5) the methods followed in preparing and cultivating the soil, and (6) the character of the soil.

### THE ROTATION OF CROPS.

The kind and quantity of fertilizer required to produce the most economical yields are greatly influenced by the rotation of crops. Tobacco, for example, takes from the soil approximately ten times as much potash as phosphoric acid, while wheat requires very nearly as much phosphoric acid as potash. The cereals, grasses, and corn are all heavy consumers of nitrogen, while the legumes may gather most of their supply of nitrogen from the air. Turning under the leaves, roots, and stems of legumes also adds a supply of humus to the soil, which is essential for the maximum effect of fertilizers. By growing crops in rotation which have different fertilizer requirements the heavy drain on the soil for any one kind of fertilizer is avoided. If legumes are grown in the rotation, as cowpeas after corn or crimson clover after cotton, then the quantity of nitrogen which need be applied in fertilizers to the corn and cotton can be greatly lessened, and in some cases dispensed with entirely, while the increased humus content of the soil, due to the plowing under of the legumes, makes more efficient the fertilizers that are applied.

A rotation, therefore, which is planned to minimize the need of commercial fertilizer should include crops of different fertilizer requirements alternating with those which add humus and nitrogen to the soil. Rotations which do not include crops that improve the humus content or add nitrogen to the soil need not be expected to reduce the fertilizer bill.

### THE GROWING OF LEGUMES.

The growing of legumes is one of the most important factors which influence the use of fertilizers. The legumes—cowpeas, clovers, vetches, and the like—if well supplied with root nodules gather much of the nitrogen needed for their growth from the air, and when the roots, fallen leaves, and stems of these plants decay they leave considerable nitrogen in the soil to be used by succeeding crops.[a] The need for commercial nitrogen will therefore be reduced when

[a] See Farmers' Bulletin 278, U. S. Department of Agriculture, entitled "Leguminous Crops for Green Manuring," 1907.

legumes are grown in the rotation, and this fact should always be considered when mixing the fertilizer for the succeeding crop. If legumes were grown in the rotation as often as they might be, in most sections of the South all, or nearly all, the nitrogen needed for other crops could be procured in this way.

In many sections of North Carolina and southern Virginia farmers have greatly increased the yield of their crops by growing crimson clover and other winter legumes. In every section of the southeast the great benefit derived from growing cowpeas is apparent. If enough leguminous crops were grown in this territory to furnish all the nitrogen now employed in the fertilizers used they would reduce the fertilizer bills more than $8,000,000 a year, while the yield of other crops would at the same time be increased by at least one-fourth.

### THE USE OF GREEN MANURE AND WINTER COVER CROPS.

Winter cover crops reduce the need for commerical fertilizer by appropriating to their own use the soluble plant constituents left by the preceding crop that would be leached out of the soil during the rainy season in winter. When these crops are turned under in the spring they not only return to the soil the fertilizer constituents which they have gathered, but their tops and roots when decomposed furnish decayed vegetable matter, or humus, which increases bacterial action. This is believed to be an important factor in crop production.

When legumes are used as winter cover crops they serve a double purpose: (1) They prevent leaching and washing and (2) they gather nitrogen which may be used by succeeding crops. On one of the North Carolina state farms one field has been cropped in corn and crimson clover six years in succession. The clover makes its growth during the winter and early spring and is turned under about the last of April and the land prepared for corn. The fertilizer used on this field has been phosphoric acid and potash without nitrogen. Under this system of double cropping, the yield of corn has increased from 20 to more than 70 bushels an acre. This is a splendid illustration of the great benefit derived from turning under winter cover crops which add nitrogen-bearing humus to the soil.

Crops other than legumes may be used as winter covers and green manures. Any of the winter cereals may be used for this purpose, but rye is probably the best one to use, as it seldom winterkills. It also makes a rapid growth in the early spring, thus enabling the farmer to turn under considerable material in time to plant either cotton, corn, or tobacco. One of the special advantages of this crop is its ability to make a fair growth in very poor soil. For this reason it is often grown on such soil and turned under for the purpose of getting the land in a condition suitable for growing legumes. Rye is also used to good advantage as a green-manure crop in well-

planned rotations on good soils. It makes an early spring growth, and when turned under green it decays rapidly. Rye is generally considered one of the best green manures for tobacco in the South Atlantic States.

## THE USE OF BARNYARD MANURE.

On farms where enough cattle are kept to consume a large portion of the farm crops and the manure is carefully saved, about three-fourths of the fertilizer constituents contained in the feed consumed may be returned to the soil. This manure adds a certain amount of fertilizer constituents and thus reduces the need for artificial supplies. Manure also adds a large quantity of organic matter to the soil, which upon decaying greatly improves the physical condition of the soil and makes more readily available for crop use the mineral fertilizer constituents already in the soil. Consequently, smaller applications of commercial fertilizers will often produce better results than larger applications on soils lacking in humus.

## METHODS OF PREPARING AND CULTIVATING THE SOIL.

Thorough preparation and tillage of the soil are so generally known to be important factors in the production of crops that only brief mention of them will be made. It has been demonstrated by farm practice that where the soil is plowed deep more fertilizer can be used profitably than on soil plowed shallow. Deep preparation and thorough tillage not only increase the productiveness of the soil by improving its texture, but also improve the conditions which favor the action of fertilizers. On permeable, mellow soils in good tilth fertilizers are much more efficient than on cloddy, poorly prepared, and poorly tilled ground.

## THE CHARACTER OF THE SOIL.

Investigations of farm practice in the use of fertilizer have shown that there is a decided variation in the quantity and proportion in which the fertilizer constituents are required to produce like yields of the same crop on different soils. Some of the variations are discussed in detail in the following pages, with particular reference to the South Atlantic States.

### Sandy soils.

Under sandy soils are included those soils of the Coastal Plain region and of the adjacent sand hills that are sand to a depth of 2 feet or more and underlaid by a very sandy subsoil. These soils vary from a rather coarse to a fine sand and occupy a considerable area of the Coastal Plain from Norfolk, Va., to Mobile, Ala.

The open structure of these soils permits the escape of soluble fertilizer constituents, especially nitrogen, and admits heat and air freely, so that organic matter decays rapidly. These combined conditions make permanent improvement of such soils difficult. To keep them in a high state of productivity a rotation of crops must be practiced that will continue to add to the soil an abundance of organic matter that will aid in holding soluble fertilizer constituents and retain soil moisture during dry weather.

### Sandy loam soils.

Sandy loam soils vary from medium to fine sandy loams, and at a depth of 6 to 12 inches are underlaid by a light clay subsoil that varies in color from light red to yellow. The sandy loam soils occupy the larger part of the Coastal Plain region not covered by the sandy soils and a considerable portion of the low hills of the adjacent Piedmont section from the southern part of Virginia to the central part of Alabama.

The surface soils of this class have a finer texture than the sandy soils, and the subsoil contains clay, both of which aid in preventing the organic matter from disappearing so rapidly. The sandy loam soils are easily cultivated and are adapted to the growth of a greater variety of crops than any other soils in these States. Consequently, it is possible to arrange a crop rotation that will, with the aid of fertilizer properly used, maintain and even increase the fertility of the soil and permit the farmer to greatly increase his income.

### Gray loam soils.

The term "gray loam soils" is very indefinite, but is here used to designate those soils of the Piedmont section that have a gravelly to sandy loam surface and are underlaid by a clay subsoil that varies from a yellow to a retentive red clay. The surface soil varies in depth from 4 to 10 inches, and in color from almost white to light red, with gray predominating. Soils of this class are found largely on the eastern edge of the Piedmont belt that extends across all the Southeastern States except Florida. The surface soils of this class are fairly open, but, on account of the clay subsoil, improvement of a permanent nature is less difficult than in the case of those of the Coastal Plain region. While the organic matter in these soils decays almost as rapidly as on the sandy loams, soluble fertilizer constituents are held better, and as a rule less fertilizer is required to produce like results.

### Red clay soils.

Red clay soils vary in color from a light-red (which often has considerable sand and gravel intermixed) to a dark-chocolate loam having fine sand intermixed with clay and silt. The surface soil

usually varies in depth according to the depth of plowing. Subsoils of this class are generally red to dark-red clay, very plastic when wet, but on drying crumble easily. Speaking in a general way, these soils occupy the upper half of the Piedmont plateau, extending through North Carolina, South Carolina, Georgia, and to about the central part of Alabama.

The retentive character of both the surface soil and subsoil of the red clay types makes them hold fertilizer constituents well. On account of the suitability of these soils for the growing of grain, grasses, and legumes it is possible to arrange a rotation of crops that will produce very profitable returns and at the same time minimize the need for commercial fertilizer. While these soils are hard to cultivate they are generally quite fertile, and may be permanently improved to a high state of productivity.

## SUMMARY OF FACTORS IN FERTILIZING.

The importance of taking into consideration all the factors which influence the use of fertilizer can hardly be overestimated. A plant must have each one of the essential fertilizer constituents present in an available form or its growth will be hindered in proportion to the deficiency of the lacking constituent. When the soil is rich in a given fertilizer constituent which is present in an available form, it will not be detrimental to the crop if that constituent is omitted in the fertilizer applied. If, on the other hand, the soil be deficient in a fertilizer constituent that is omitted in the fertilizer, the crop yield will decrease in proportion to the insufficient supply of that constituent. When mixing fertilizer for the different crops, the amount of fertilizer which has been added to the soil in barnyard manure, green manures, and leguminous crops should be considered, and no more of any one fertilizer constituent should be applied than is likely to be beneficial. A crop is not benefited by supplying it with more fertilizer than is needed. An excess of one or more fertilizer constituents not only fails to increase but often decreases the yield of crops, as shown both by experiments and by field practice.

To properly adjust the fertilizer constituents the farmer must study his conditions. No definite quantity or proportion of fertilizer constituents can ever be given that will meet the needs of a crop under all conditions. The rotation of crops, the growing of legumes, the use of crops for green manuring, the application of barnyard manure, the methods of preparation and cultivation, and the character of the soil will always be factors which must be taken into consideration when using commercial fertilizer.

## THE USE OF LIME.

The use of lime in the agriculture of the South Atlantic States has not been well established. On the principal cotton soils of the section lime has not proved beneficial in increasing the yields of

general crops. There are sections in the extreme western part of the Piedmont belt in the Carolinas and Georgia where the failure of red clover indicates the need of lime. There are also numerous small areas of swamp land in the Coastal Plain region that have been drained on which the use of lime has been beneficial. Beyond these local areas so little is definitely known regarding the value of lime in southern agriculture that a full discussion of the subject is omitted. The general conditions under which lime may be used profitably and directions for its use are given in another bulletin of this series.[a]

## FARM FERTILIZER PRACTICE IN THE SOUTH ATLANTIC STATES.

In tabulating the results obtained in the investigations in the South Atlantic States it was found desirable to divide the farms studied into two classes, which, for convenience, are denominated Class A and Class B. This division is justified by differences in methods of management and the marked differences in the results obtained.

### FARMS OF CLASS A.

The farms of Class A are conducted by men who grow profitable crops and at the same time maintain or increase the fertility of their farms. They practice good crop rotations, deep plowing, and up-to-date methods of management, linked with an intelligent, systematic, and judicious use of fertilizers. No farms are included in this class on which the yields are less than 1,200 pounds of seed cotton, 40 bushels of corn, or 40 bushels of oats to the acre, and other crops in proportion. The principal rotations practiced by these farmers may be mentioned in the order in which they are most frequently used:

| | |
|---|---|
| Three-year rotation.. | First year: Cotton.<br>Second year: Corn, cowpeas, vines turned under.<br>Third year: Oats, cowpeas, vines cut for hay. |
| Two-year rotation.... | First year: Cotton, oats seeded on one-half of land.<br>Second year: Oats, cowpeas, vines cut for hay; corn, cowpeas, vines left on the land. |
| Three-year rotation.. | First year: Cotton, crimson clover seeded in August or September.<br>Second year: Corn.<br>Third year: Oats or wheat, cowpeas, vines cut. |
| Three-year rotation.. | First year: Rye turned under, cotton.<br>Second year: Corn, cowpeas, vines turned under.<br>Third year: Oats, cowpeas, vines cut, rye seeded. |
| Four-year rotation... | First year: Corn, cowpeas.<br>Second year: Wheat, clover.<br>Third year: Clover.<br>Fourth year: Clover or cotton. |

[a] See Farmers' Bulletin 77, U. S. Department of Agriculture, entitled "The Liming of Soils," 1905.

## FARMS OF CLASS B.

The farms of Class B are conducted by farmers who, as a rule, produce only moderately paying crops, and more often decrease than increase the fertility of their farms. In many cases poor judgment is used in buying and using fertilizer, and little consideration is given to rotation and good management. The average yields on these farms are from 600 to 1,200 pounds of seed cotton, 15 to 40 bushels of corn, and 20 to 40 bushels of oats to the acre, and other crops in proportion. Instead of well-planned rotations in which crops are changed in a systematic manner, one crop is often grown on the same land several years in succession without any intervening crop to gather nitrogen or add humus to the soil. The low yields show plainly the effect of poor management, lack of rotation, and poor judgment in applying fertilizer.

Table I gives a summary of the data collected for these two classes of farms in the conduct of investigations. Figures 1 and 2 give this same data in diagrammatic form.

TABLE I.—*Kinds and quantity of fertilizer constituents used on various kinds of soil in the growing of cotton, corn, and oats on farms of Class A and Class B[a] in the South Atlantic States.*

CLASS A FARMS.

| Crop. | Kind of soil. | Men furnishing data. | Fertilizer constituents used to the acre. | | |
|---|---|---|---|---|---|
| | | | Phosphoric acid. | Ammonia. | Potash. |
| | | *Number.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Cotton | Sandy | 12 | 57 | 25 | 36 |
| | Sandy loam | 30 | 48 | 22 | 27 |
| | Gray loam | 23 | 37 | 15 | 15 |
| | Red clay | 18 | 33 | 12 | 12 |
| Corn | Sandy | 11 | 43 | 27 | 32 |
| | Sandy loam | 23 | 35 | 23 | 23 |
| | Gray loam | 20 | 30 | 18 | 17 |
| | Red clay | 14 | 30 | 15 | 11 |
| Oats | Sandy | 3 | 35 | 26 | 24 |
| | Sandy loam | 7 | 30 | 21 | 21 |
| | Gray loam | 7 | 36 | 21 | 16 |
| | Red clay | 8 | 26 | 13 | 12 |

CLASS B FARMS.

| | | | | | |
|---|---|---|---|---|---|
| Cotton | Sandy | 24 | 43 | 21 | 24 |
| | Sandy loam | 51 | 37 | 15 | 16 |
| | Gray loam | 14 | 39 | 11 | 14 |
| | Red clay | 25 | 33 | 12 | 11 |
| Corn | Sandy | 17 | 20 | 18 | 13 |
| | Sandy loam | 42 | 24 | 14 | 13 |
| | Gray loam | 24 | 20 | 9 | 12 |
| | Red clay | 32 | 27 | 11 | 11 |
| Oats | Sandy | 6 | 22 | 21 | 12 |
| | Sandy loam | 10 | 24 | 17 | 8 |
| | Gray loam | 6 | 11 | 4 | 7 |
| | Red clay | 6 | 24 | 14 | 14 |

[a] For explanation of this classification, see pp. 11-12.

The perpendicular lines in the diagrams of figures 1 and 2 represent the different soils previously described. The horizontal lines represent the number of pounds of fertilizer constituents used. The heavy

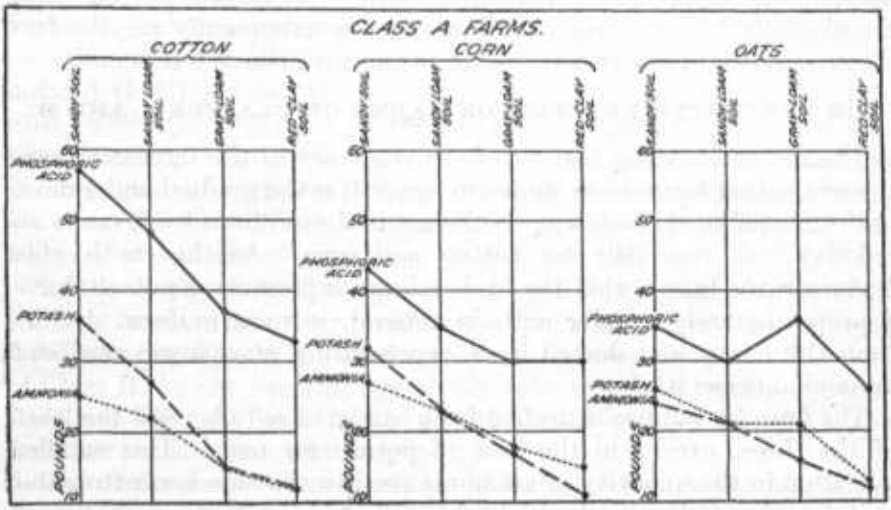


FIG. 1.—Diagram showing the quantity of phosphoric acid, ammonia, and potash used to the acre by farmers of Class A on various kinds of soil for cotton, corn, and oats.

line, the broken line, and the dotted line represent phosphoric acid, potash, and ammonia, respectively. These cross the perpendicular and horizontal lines and show at their points of crossing the average

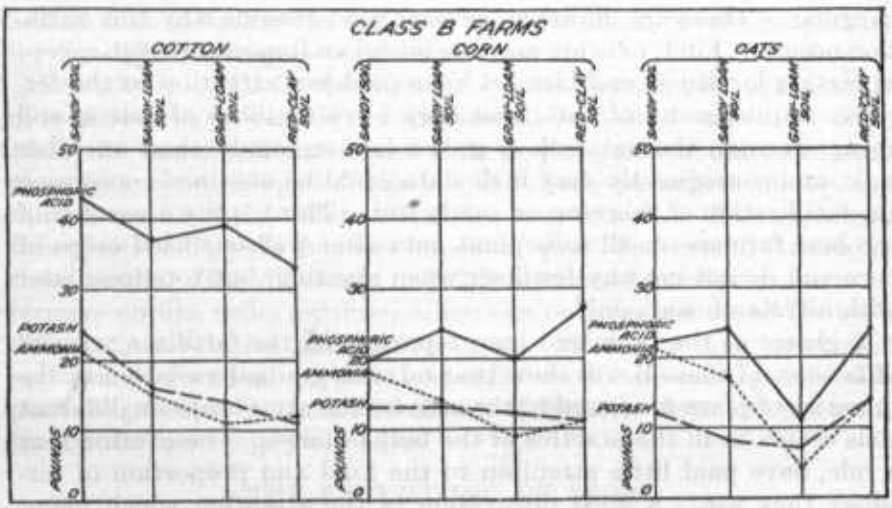


FIG. 2.—Diagram showing the quantity of phosphoric acid, ammonia, and potash used to the acre by farmers of Class B on various kinds of soil for cotton, corn, and oats.

number of pounds of the different fertilizer constituents applied to each crop on the different soils. For example, take the perpendicular line marked "sandy loam soil," under cotton, in the upper left-hand

corner of figure 1. This is crossed by the heavy, broken, and dotted lines at 48, 27, and 22, and shows that the best farmers use on sandy loam soils on the average 48 pounds of phosphoric acid, 27 pounds of potash, and 22 pounds of ammonia to the acre for the cotton crop. By carefully looking over the diagrams one can readily see the fertilizer practice of the two classes of farmers on the different soils.

### THE FERTILIZER PRACTICE ON FARMS OF CLASSES A AND B.

The most noticeable feature of the summary of the fertilizer practice of the best farmers, as shown in figure 1, is the gradual and almost uniform decline of the heavy, broken, and dotted lines from sandy to red clay soil, especially for cotton and corn. Another noticeable feature in the lines is that the broken lines, representing potash, have a proportionately greater and, in general, a more uniform decline than the heavy and dotted lines, representing phosphoric acid and ammonia, respectively.

The lines for ammonia decline from sandy to red clay soil the least of the three, except in the case of potash for oats. This smaller variation in the quantity of ammonia used to the acre for cotton and corn on the various soils might be expected, as the percentage of nitrogen in different soils on which similar rotations of crops are practiced probably varies less than the percentage of either phosphoric acid or potash.

The variation in the quantity of both ammonia and phosphoric acid used by the best farmers for oats on the different soils is very irregular. There are, however, several good reasons why this variation occurs. First, oats are not considered an important crop, except in certain localities, and farmers have paid less attention to the fertilizer requirements of oats than they have to those of cotton and corn. Second, the oat crop is grown less on sandy than on other soils, and consequently very little data could be obtained concerning the fertilization of this crop on sandy soil. Third, quite a number of the best farmers on all soils plant oats after well-fertilized crops of corn and do not use any fertilizer when planting, but top-dress later with nitrate of soda only.

A glance at the table and lines representing the fertilizer practice of farmers of Class B will show that no such gradual variation in the quantity of plant food used to the acre for the same crops on different soils occurs as in the practice of the best farmers. These farmers, as a rule, have paid little attention to the kind and proportion of fertilizer they use. A good illustration of the attention which many farmers give to the proportion in which the fertilizer constituents are used is afforded by the farmer who, after fertilizing his cotton and tobacco crops, took all the odds and ends of fertilizing materials on hand and mixed them together for the corn crop. Under conditions

of this kind the fertilizer practice of such farmers could hardly be expected to be similar to that of the best farmers, except by accident.

In comparing the fertilizer practice of the best (Class A) and second-best (Class B) farmers, it will be noticed that the greatest actual variation in the number of pounds to the acre of any one fertilizer constituent is found in the case of phosphoric acid. It will also be noticed that the least variation occurs in the quantity of ammonia used, while the variation in the quantity of potash is between the two extremes. A further study of the diagrams shows that the greatest general variation in quantity of all the fertilizer constituents between the two classes of farmers occurs on sandy soil, and the least, or practically no variation, on red clay soil.

In the study of fertilizer practice it was found that nearly all of the best farmers mix their fertilizers at home and adjust the different fertilizer constituents to suit the needs of the crop and soil. Farmers of Class B, on the contrary, generally take what the fertilizer manufacturers offer for sale regardless of the proportion in which the fertilizer constituents are supplied.

One of the most common grades of fertilizer put on the market in the South at present is one containing 8 per cent of phosphoric acid, 3 per cent of ammonia, and 3 per cent of potash. It happens that this fertilizer contains the three fertilizer constituents in almost exactly the proportion in which they give the best results for cotton on red clay soil under fairly good methods of rotation. The average farmer accepts the fertilizer mixtures put up by the manufacturer and so fails to secure the fertilizer constituents in proper proportion for the different crops, except on red clay soil.

But why is it that the best farmers on red clay soil get 1,200 pounds of seed cotton, 40 bushels of corn, and 40 bushels of oats to the acre, while the farmers of our second class produce only about two-thirds these quantities, in spite of the fact that both use approximately the same amounts of the different fertilizer constituents? The answer to this question suggests the most important part of successful farming in these States. The difference in yields obtained by the two classes of farmers on like soils, fertilized alike, can only be accounted for by a difference in rotation and management. When the same or similar methods of rotation, preparation, cultivation, and management are put into practice by these two classes of farmers, then, and not until then, will their crops yield alike.

## THE FERTILIZING OF CROPS.

The quantities of the different fertilizer constituents and the fertilizer formulas suggested in the following pages are based on the best farm practice, as previously described, coordinated with the results of experiment-station work and with fertilizer tests made by prac-

tical farmers in many sections of the South Atlantic States. The combinations and quantities of fertilizing materials recommended in the following pages for the different crops and soils may not always be the most economical and profitable to use. The fertilizer constituents are, however, in the best proportion that can be suggested from the data available, and they may be safely used for present crop production and as a basis for further investigation. They are intended to meet conditions of rotation similar to those of the best farmers, previously described. On farms where the rotations are different and where the grades of soil are between those previously described, the farmer, after carefully studying his conditions, should adjust the fertilizer constituents to suit the needs of his soil and cropping system. Generally, as soil conditions are improved, the quantity of fertilizer necessary to use for a given crop yield can be considerably reduced.

Table II shows in concrete form the total number of pounds of the different fertilizer constituents recommended for cotton, corn, oats, and wheat on each of the more common kinds of soils of the Southeast.

TABLE II.—*Quantities of fertilizer constituents suggested for crops on various kinds of soil under good conditions of rotation and management. The fertilizer constituents are quoted in the terms and in the order commonly used in the Southeastern States.*

| Crop. | Kind of soil. | Fertilizer constituents suggested to the acre. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia. | Potash. |
| | | *Pounds.* | *Pounds.* | *Pounds.* |
| Cotton | Sandy | 38 | 26 | 36 |
| | Sandy loam | 50 | 22 | 30 |
| | Gray loam | 40 | 16 | 18 |
| | Red clay | 34 | 13 | 13 |
| Corn | Sandy | 36 | 26 | 40 |
| | Sandy loam | 34 | 22 | 34 |
| | Gray loam | 30 | 18 | 24 |
| | Red clay | 26 | 16 | 16 |
| Oats | Sandy | 36 | 24 | 30 |
| | Sandy loam | 30 | 22 | 25 |
| | Gray loam | 24 | 20 | 18 |
| | Red clay | 20 | 18 | 16 |
| Wheat | Sandy loam | 28 | 20 | 18 |
| | Gray loam | 24 | 18 | 14 |
| | Red clay | 20 | 16 | 10 |

In making up the total quantity of the different fertilizer constituents suggested in Table II for the various crops, fertilizing materials of different availability should be used. Nitrogen should be obtained from readily or slowly available sources, or both, as indicated in the fertilizer mixtures suggested for each crop. Phosphoric acid and potash may be obtained from any of the standard materials.

In Table III are listed a number of standard fertilizing materials that may be used in compounding fertilizer. These materials can usually be obtained from wholesale dealers, and in many cases from retail dealers.

TABLE III.—*Kinds of fertilizers commonly used and the approximate quantity of fertilizing constituents in 100 pounds of each.*

| Fertilizing material. | Availability of plant food. | Kinds and quantity of fertilizer constituents in 100 pounds of fertilizer. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia.[a] | Potash. |
| | | *Pounds.* | *Pounds.* | *Pounds.* |
| Nitrate of soda | Readily available | ..... | 18 to 19 | ..... |
| Fish scraps | Medium availability | 6 to 10 | 8 to 11 | ..... |
| Dried blood | do | ..... | 13 to 15 | ..... |
| Cotton-seed meal | do | 1 to 2 | 6.5 to 8 | 1 to 1.5 |
| Slaughterhouse tankage | do | 7 to 11 | 8 to 12 | ..... |
| Acid phosphate | Readily available | 13 to 16 | ..... | ..... |
| Basic slag | Medium availability | 15 to 17 | ..... | ..... |
| Ground bone | Slowly available | 22 to 25 | 2 to 4 | ..... |
| Raw rock phosphate[b] | Very slowly available | 26 to 36 | ..... | ..... |
| Muriate of potash | Readily available | ..... | ..... | 48 to 52 |
| Kainit | do | ..... | ..... | 12 to 13 |
| Sulphate of potash[c] | do | ..... | ..... | 46 to 50 |

[a] Multiply ammonia by 0.82 to obtain its equivalent in nitrogen.
[b] This material should be used only when the soil is well filled with humus.
[c] Sulphate of potash may be used to best advantage for potatoes, tobacco, melons, onions, peaches, and other fruits.

## FERTILIZING COTTON.

By practicing good rotations the best farmers have their soil fairly well supplied with humus, and consequently find it a good practice to apply all the fertilizer several days before planting. However, on soils very deficient in humus, farmers find that it is more profitable to apply about one half of the fertilizer before planting and retain the other half to be used as a side application about the middle of June.

The fertilizer may be applied either with a distributer or by hand. The chief aim of the best farmers is to get it scattered over a surface at least 6 inches broad and well mixed with the soil. It has been found that an even distribution of the fertilizer over a surface 6 or 8 inches broad is necessary to induce an early and continuous growth of cotton.

On farms where a heavy crop of crimson clover, vetch, or some other legume is turned under as a green manure for the cotton crop, no ammonia need be used in the fertilizer. But when legumes are grown less often and practically all are cut for hay, as indicated in the rotations of the best farmers, the fertilizer should carry about as much ammonia as suggested in Table IV. Farm practice has shown that it is best to use a readily available fertilizing material to furnish about one-third of the total ammonia. The other two-thirds may be supplied from any of the other nitrogenous materials specified in Table III. The number of pounds of the three essential fertilizer constituents and the mixtures given for furnishing these constituents suggested in Table IV are to be used under conditions of rotation similar to those practiced by farmers of Class A.

TABLE IV.—*Quantity and composition of fertilizer mixtures suggested for application to each acre of cotton grown on various kinds of soil.*

| Fertilizing material. | Quantity of each constituent. | Fertilizer constituents contained in mixture. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia. | Potash. |
| **SANDY SOIL—FIRST SUGGESTION.** | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Acid phosphate, 16 per cent | 350 | 56.0 | ..... | ..... |
| Cotton-seed meal, 1-7.5-1 per cent [a] | 240 | 2.4 | 18.0 | 2.4 |
| Nitrate of sode, 18 per cent | 45 | ..... | 8.1 | ..... |
| Muriete of potash, 50 per cont | 68 | ..... | ..... | 34.0 |
| (Or 272 pounds of 12.5 per cent kainit.) | | | | |
| Total | ..... | 58.4 | 20.1 | 30.4 |
| **SANDY SOIL—SECOND SUGGESTION.** | | | | |
| Acid phosphate, 14 per cent | 415 | 58.1 | ..... | ..... |
| Dried blood, 14 per cent [b] | 125 | ..... | 17.5 | ..... |
| Nitrete of soda, 18 per cent | 50 | ..... | 9.0 | ..... |
| Muriate of potash, 50 per cent | 72 | ..... | ..... | 36.0 |
| (Or 288 pounds of 12.5 per cent keinit.) | | | | |
| Total | ..... | 58.1 | 26.5 | 36.0 |
| **SANDY LOAM SOIL—FIRST SUGOESTION.** | | | | |
| Acid phosphate, 16 per cent | 300 | 48.0 | ..... | ..... |
| Cotton-seed meal, 1-7.5-1 per cent [a] | 215 | 2.2 | 16.1 | 2.2 |
| Nitrate of soda, 18 per cent | 35 | ..... | 6.3 | ..... |
| Muriete of potash, 50 per cent | 56 | ..... | ..... | 28.0 |
| (Or 224 pounds of 12.5 per cent kainit.) | | | | |
| Total | ..... | 50.2 | 22.4 | 30.2 |
| **SANDY LOAM SOIL—SECOND SUGOESTION.** | | | | |
| Acid phosphate, 14 per cent | 360 | 50.4 | ..... | ..... |
| Dried blood, 14 per cent [b] | 115 | ..... | 10.1 | ..... |
| Nitrate of sode, 18 per cent | 35 | ..... | 6.3 | ..... |
| Muriate of potash, 50 per cent | 60 | ..... | ..... | 30.0 |
| (Or 240 pounds of 12.5 per cent kainit.) | | | | |
| Total | ..... | 50.4 | 22.4 | 30.0 |
| **GRAY LOAM SOIL—FIRST SUGOESTION.** | | | | |
| Acid phosphate, 16 per cent | 250 | 40.0 | ..... | ..... |
| Cotton-seed meal, 1-7.5-1 per cent [a] | 130 | 1.3 | 9.8 | 1.3 |
| Nitrate of soda, 18 per cont | 35 | ..... | 6.3 | ..... |
| Muriete of potash, 50 per cent | 34 | ..... | ..... | 17.0 |
| (Or 136 pounds of 12.5 per cent kainit.) | | | | |
| Total | ..... | 41.3 | 10.1 | 18.3 |
| **GRAY LOAM SOIL—SECONN SUGGESTION.** | | | | |
| Acid phosphate, 14 per cent | 285 | 39.9 | ..... | ..... |
| Dried blood, 14 per cent [b] | 75 | ..... | 10.5 | ..... |
| Nitrete of sode, 18 per cent | 30 | ..... | 5.4 | ..... |
| Muriete of potash, 50 per cent | 36 | ..... | ..... | 18.0 |
| (Or 144 pounds of 12.5 per cent kainit.) | | | | |
| Total | ..... | 39.9 | 15.9 | 18.0 |
| **RED CLAY SOIL—FIRST SUGGESTION.** | | | | |
| Acid phosphate, 16 per cent | 210 | 33.6 | ..... | ..... |
| Cotton-seed meel, 1-7.5-1 per cent [a] | 120 | 1.2 | 9.0 | 1.2 |
| Nitrate of soda, 18 per cent | 25 | ..... | 4.5 | ..... |
| Muriate of potash, 50 per cent | 25 | ..... | ..... | 12.5 |
| (Or 100 pounds of 12.5 per cent keinit.) | | | | |
| Total | ..... | 34.8 | 13.5 | 13.7 |
| **RED CLAY SOIL—SECOND SUGGESTION.** | | | | |
| Acid phosphate, 14 per cent | 245 | 34.3 | ..... | ..... |
| Dried blood, 14 per cent [b] | 65 | ..... | 9.1 | ..... |
| Nitrate of soda, 18 per cent | 25 | ..... | 4.5 | ..... |
| Muriate of potash, 50 per cent | 26 | ..... | ..... | 13.0 |
| Total | ..... | 34.3 | 13.0 | 13.0 |

[a] Equals 1 per cent of phosphoric acid, 7.5 per cent of ammonia, and 1 per cent of potash.
[b] Slaughterhouse tenkage may be substituted for dried blood if, on the basis of the weight of plant food contained, it is cheeper.

In Table V the quantities, given in pounds, of mixed fertilizers, of the analysis given in the last three columns of the table, are equivalent in total pounds of fertilizer constituents to those recommended to be used in the mixtures given in Table IV. Thus, 725 pounds of 8:3.6:5 goods contain the same quantities of phosphoric acid, ammonia, and potash as the mixtures given for cotton on sandy soil in Table IV.

TABLE V.—*Quantity and composition of a mixed fertilizer of definite analysis suggested for application to each acre of cotton grown on various kinds of soil.*

| Kind of soil. | Quantity of mixed fertilizer. | Composition of mixture. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia. | Potash. |
| | *Pounds.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Sandy | 725 | 8.0 | 3.6 | 5.0 |
| Sandy loam | 625 | 8.0 | 3.5 | 4.8 |
| Gray loam | 500 | 8.0 | 3.6 | 3.6 |
| Red clay | 425 | 8.0 | 3.06 | 3.06 |

## FERTILIZING CORN.

A method of fertilizing corn widely used, and apparently worthy of commendation, in the South Atlantic States is to plant the corn below the level of the soil and cultivate once or twice before making the first application of fertilizer. Some farmers make this application on each side of the row, while others think it is practically as beneficial and more economical to apply to one side only. The prevailing practice is to make the first application of fertilizer when the corn is about 2 feet high and use two-thirds of the total phosphoric acid and potash and one-half of the nitrogen that is to be used on the crop. The fertilizer is distributed evenly over a furrow at least 4 inches broad, 3 or 4 inches deep, and about 8 inches from the row of corn. The fertilizer is then covered by cultivating the corn shallow.

The second, or last, application of fertilizer, consisting of one-third of the total phosphoric acid and potash and one-half of the nitrogen, is made about the time the corn prepares for tasseling. This application is made on the opposite side of the row from the first, in order to make a uniform distribution of the fertilizer. The corn is usually cultivated for the last time immediately after the fertilizer is distributed.

For the first application of fertilizer, materials furnishing nitrogen or ammonia in a slowly available form, such as cotton-seed meal, dried blood, and tankage, should be used. For the second application it is preferable to use nitrogen in a readily available form, like nitrate of soda. The amount of nitrogen necessary to produce a good corn crop will depend upon the rotation. When a heavy crop of crimson clover is turned under as a green manure for corn the nitrogen may be economically omitted from the fertilizer.

Table VI shows the quantities of the essential fertilizer constituents and fertilizer mixtures suggested for corn on the different soils under conditions of rotation such as the best farmers practice.

TABLE VI.—*Quantity and composition of fertilizer mixtures suggested for two applications to each acre of corn grown on various kinds of soil.*

| Fertilizing material. | Quantity suggested. | Fertilizer constituents contained in mixture. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia. | Potash. |
| SANDY SOIL—FIRST APPLICATION. | | | | |
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Cotton-seed meal, 1-7.5-1 per cent[a] | 175 | 1.7 | 13.1 | 1.7 |
| Acid phosphate, 16 per cent | 140 | 22.4 | ..... | ..... |
| Muriate of potash, 50 per cent | 54 | ..... | ..... | 27.0 |
| Total | ..... | 24.1 | 13.1 | 28.7 |
| SANDY SOIL—SECOND APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 75 | 12.0 | ..... | ..... |
| Nitrate of soda, 18 per cent | 75 | ..... | 13.5 | ..... |
| Muriate of potash, 50 per cent | 24 | ..... | ..... | 12.0 |
| Total | ..... | 12.0 | 13.5 | 12.0 |
| Total, first and second applications | ..... | 36.1 | 26.6 | 40.7 |
| SANDY LOAM SOIL—FIRST APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 125 | 20.0 | ..... | ..... |
| Cotton-seed meal, 1-7.5-1 per cent[a] | 150 | 1.5 | 11.2 | 1.5 |
| Muriate of potash, 50 per cent | 43 | ..... | ..... | 21.5 |
| Total | ..... | 21.5 | 11.2 | 23.0 |
| SANDY LOAM SOIL—SECOND APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 75 | 12.0 | ..... | ..... |
| Nitrate of soda, 18 per cent | 60 | ..... | 10.8 | ..... |
| Muriate of potash, 50 per cent | 24 | ..... | ..... | 12.0 |
| Total | ..... | 12.0 | 10.8 | 12.0 |
| Total, first and second applications | ..... | 33.5 | 22.0 | 35.0 |
| GRAY LOAM SOIL—FIRST APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 120 | 19.2 | ..... | ..... |
| Cotton-seed meal, 1-7.5-1 per cent[a] | 120 | 1.2 | 9.0 | 1.2 |
| Muriate of potash, 50 per cent | 30 | ..... | ..... | 15.0 |
| Total | ..... | 20.4 | 9.0 | 16.2 |
| GRAY LOAM SOIL—SECOND APPLICATION. | | | | |
| Nitrate of soda, 18 per cent | 50 | ..... | 9.0 | ..... |
| Acid phosphate, 16 per cent | 60 | 9.6 | ..... | ..... |
| Muriate of potash, 50 per cent | 16 | ..... | ..... | 8.0 |
| Total | ..... | 9.6 | 9.0 | 8.0 |
| Total, first and second applications | ..... | 30.0 | 18.0 | 24.2 |
| RED CLAY SOIL—FIRST APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 155 | 24.8 | ..... | ..... |
| Cotton-seed meal, 1-7.5-1 per cent[a] | 110 | 1.1 | 8.2 | 1.1 |
| Muriate of potash, 50 per cent | 32 | ..... | ..... | 16.0 |
| Total | ..... | 25.9 | 8.2 | 17.1 |
| RED CLAY SOIL—SECOND APPLICATION. | | | | |
| Nitrate of soda, 18 per cent | 45 | ..... | 8.1 | ..... |
| Total, first and second applications | ..... | 25.9 | 16.3 | 17.1 |

[a] Equals 1 per cent of phosphoric acid, 7.5 per cent of ammonia, and 1 per cent of potash.

The amount of fertilizer constituents for corn on various kinds of soil suggested in Table VI may be secured by using the quantities of mixed fertilizer of the analysis given in Table VII.

TABLE VII.—*Quantity and composition of a mixed fertilizer of definite analysis suggested for application to each acre of corn grown on various kinds of soil.*

| Kind of soil. | Quantity of mixed fertilizer. | Composition of mixture. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia. | Potash. |
| | *Pounds.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Sandy | 450 | 8.9 | 5.75 | 8.9 |
| Sandy loam | 425 | 8.0 | 5.2 | 8.0 |
| Gray loam | 375 | 8.0 | 4.8 | 6.4 |
| Red clay | 325 | 8.0 | 4.92 | 4.92 |

## FERTILIZING OATS.

There are two methods of fertilizing oats applicable to different conditions which can be recommended. The first method is suited to all soils, while the second must vary with the farming conditions and the soil.

The first method consists of applying the phosphoric acid and potash to fall oats at the time of seeding, the ammonia being retained to apply in the spring after the danger of frost has passed. Immediately after the fertilizer is applied in the spring the oats are harrowed with a light smoothing harrow to cover the fertilizer.

The second method is applicable only to farms where the oat crop follows some cultivated crop that has been well fertilized. In many cases of this kind oats are seeded in the fall without fertilizer, but the following spring an application of nitrate of soda is made. This method should be practiced only when it is reasonably certain that there is sufficient available phosphoric acid and potash in the soil to grow a good crop of oats. Often the effect of the nitrate is practically lost on account of an insufficient supply of the mineral elements.

The ammonia used in the fertilizer for this crop is usually supplied from two sources, one readily available and the other slowly available. Nitrate of soda is nearly always used to supply readily available nitrogen. The quantities of fertilizer constituents and fertilizer mixtures given in Table VIII are intended to be used where a small growth of cowpea vines or the stubble of a cowpea crop is turned under. When a heavy growth of pea vines is turned under all the ammonia in the fertilizer may be dispensed with.

TABLE VIII.—*Quantity and composition of fertilizer mixtures suggested for fall and spring applications to each acre of oats grown on various kinds of soil.*

| Fertilizing material. | Quantity suggested. | Fertilizer constituents contained in mixture. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia. | Potash. |
| SANDY SOIL—FALL APPLICATION. | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Acid phosphate, 16 per cent | 225 | 30.0 | ..... | ..... |
| Muriate of potash, 50 per cent | 60 | ..... | ..... | 30.0 |
| Total | ..... | 30.0 | ..... | 30.0 |
| SANDY SOIL—SPRING APPLICATION. | | | | |
| Cotton-seed meal, 7.5 per cent | 200 | ..... | 15.0 | ..... |
| Nitrate of soda, 18 per cent | 50 | ..... | 9.0 | ..... |
| Total | ..... | ..... | 24.0 | ..... |
| Total, fall and spring applications | ..... | 30.0 | 24.0 | 30.0 |
| SANDY LOAM SOIL—FALL APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 190 | 30.4 | ..... | ..... |
| Muriate of potash, 50 per cent | 50 | ..... | ..... | 25.0 |
| Total | ..... | 30.4 | ..... | 25.0 |
| SANDY LOAM SOIL—SPRING APPLICATION. | | | | |
| Dried blood, 14 per cent | 100 | ..... | 14.0 | ..... |
| Nitrate of soda, 18 per cent. | 45 | ..... | 8.1 | ..... |
| Total | ..... | ..... | 22.1 | ..... |
| Total, fall and spring applications | ..... | 30.4 | 22.1 | 25.0 |
| GRAY LOAM SOIL—FALL APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 150 | 24.0 | ..... | ..... |
| Muriate of potash, 50 per cent | 30 | ..... | ..... | 18.0 |
| Total | ..... | 24.0 | ..... | 18.0 |
| GRAY LOAM SOIL—SPRING APPLICATION. | | | | |
| Dried blood, 14 per cent | 80 | ..... | 11.2 | ..... |
| Nitrate of soda, 18 per cent | 50 | ..... | 9.0 | ..... |
| Total | ..... | ..... | 20.2 | ..... |
| Total, fall and spring applications | ..... | 24.0 | 20.2 | 18.0 |
| RED CLAY SOIL—FALL APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 125 | 20.0 | ..... | ..... |
| Muriate of potash, 50 per cent | 32 | ..... | ..... | 16.0 |
| Total | ..... | 20.0 | ..... | 16.0 |
| RED CLAY SOIL—SPRING APPLICATION. | | | | |
| Cotton-seed meal, 7.5 per cent | 170 | ..... | 12.8 | ..... |
| Nitrate of soda, 18 per cent | 30 | ..... | 5.4 | ..... |
| Total | ..... | ..... | 18.2 | ..... |
| Total, fall and spring applications | ..... | 20.0 | 18.2 | 16.0 |

## FERTILIZING WHEAT.

The wheat crop was not considered in the summary of fertilizer practice because it is very seldom grown on any other than gray loam and red clay soils. At present prices, however, wheat could be profitably grown on some of the heavy sandy loam soils.

The fertilizer may be applied to this crop as to oats. The first method given for fertilizing oats, namely, the application of phosphoric acid and potash in the fall and of nitrogen in the spring, is

more generally suited for wheat. When phosphoric acid and potash are supplied in the fertilizer and sufficient barnyard manure is available to give the land an application of 10 tons to the acre, no ammoniated fertilizer need be applied in the spring. Likewise, when the wheat crop follows a good crop of clover or cowpeas all, or nearly all, the ammonia in the fertilizers applied may be omitted. When the wheat field is seeded to clover or clover and grass and left down for hay, more phosphoric acid and potash should be used than when no hay crop follows. The quantities of the different fertilizer constituents given in Table IX are intended for wheat under fairly good farming conditions and where the land is not to be seeded to clover and grass.

TABLE IX.—*Quantity and composition of fertilizer mixtures suggested for fall and spring applications to each acre of wheat grown on various types of soil.*

| Fertilizing material. | Quantity suggested. | Fertilizer constituents contained in mixture. | | |
|---|---|---|---|---|
| | | Phosphoric acid. | Ammonia. | Potash. |
| SANDY LOAM SOIL—FALL APPLICATION. | | | | |
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Acid phosphate, 16 per cent | 175 | 28.0 | ..... | ..... |
| Muriate of potash, 50 per cent | 36 | ..... | ..... | 18.0 |
| Total | ..... | 28.0 | ..... | 18.0 |
| SANDY LOAM SOIL—SPRING APPLICATION. | | | | |
| Nitrate of soda, 18 per cent | 110 | ..... | 19.8 | ..... |
| Total | ..... | ..... | 19.8 | ..... |
| Total, fall and spring applications | ..... | 28.0 | 19.8 | 18.0 |
| GRAY LOAM SOIL—FALL APPLICATION. | | | | |
| Acid phosphate, 16 per cent | 150 | 24.0 | ..... | ..... |
| Muriate of potash, 50 per cent | 28 | ..... | ..... | 14.0 |
| Total | ..... | 24.0 | ..... | 14.0 |
| GRAY LOAM SOIL—SPRING APPLICATION. | | | | |
| Nitrate of soda, 18 per cent | 100 | ..... | 18.0 | ..... |
| Total | ..... | ..... | 18.0 | ..... |
| Total, fall and spring applications | ..... | 24.0 | 18.0 | 14.0 |
| RED CLAY SOIL. | | | | |
| Acid phosphate, 16 per cent | 125 | 20.0 | ..... | ..... |
| Muriate of potash, 50 per cent | 20 | ..... | ..... | 10.0 |
| Dried blood, 14 per cent | 114 | ..... | 15.9 | ..... |
| Total | ..... | 20.0 | 15.9 | 10.0 |

## FERTILIZING COWPEAS.

The results of farm practice indicate that it is not profitable to fertilize the cowpea crop when grown on good soil or when it follows crops that have been fertilized heavily. On the other hand, when the cowpea is planted on poor soil it should receive some fertilizer, the kind and quantity depending on the kind of soil and how badly it is run down.

On ordinary poor sandy, sandy loam, and gray loam soils 200 pounds of acid phosphate and 50 to 100 pounds of kainit to the acre have been the most profitable kinds and quantities of fertilizing materials used.

On red clay soil 200 pounds of acid phosphate to the acre have produced the most profitable crops.

When the soil is very badly run down a small quantity of cottonseed meal, dried blood, or some other ammoniated fertilizing material should be added to the mineral fertilizer used. This ammoniated material will be needed only on soils too poor to maintain the plants in good growing condition until they are able to gather nitrogen from the air.

## SUMMARY.

(1) Commercial fertilizers are expensive. Accurate information is needed for their economic use.

(2) With a good rotation, deep and thorough tillage, and the use of green manures, legumes, and winter cover crops, the quantity of commercial fertilizers required for a given crop yield can be considerably reduced.

(3) The character of the soil has a marked influence on the quantity and kind of fertilizer it is necessary to use in a good system of farming.

(4) In farm practice there is a gradual increase in the quantity of all the fertilizer constituents required to produce like yields as the proportion of sand in the surface and subsoil increases. The increase is greatest in the quantity of potash necessary, followed by phosphoric acid, and then by nitrogen.

(5) A study of farm practice shows that the best farmers, those referred to in this bulletin as belonging to Class A, obtain yields of 1 to 2 bales of cotton, 40 to 75 bushels of corn, and 40 to 75 bushels of oats on soils where farmers of Class B get but one-half to 1 bale of cotton, 15 to 40 bushels of corn, and 15 to 40 bushels of oats, due to the fact that the best farmers have a better understanding of the use of fertilizers and employ better farm methods.

(6) One of the most common grades of fertilizer on the market in the South Atlantic States at present contains 8 per cent of phosphoric acid, 3 per cent of ammonia, and 3 per cent of potash. This grade of fertilizer is of primary value only for cotton on red clay soil under fairly good methods of rotation. This fertilizer formula needs to be greatly modified for crops on sandy, sandy loam, and gray loam soils, and for all crops other than cotton on red clay soil.

(7) Detailed suggestions are contained in this bulletin on the best method of fertilizing and the most profitable kinds of fertilizer constituents to apply on soils of different character to cotton, corn, oats, wheat, and cowpeas.

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